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SYNOPSIS OF NORTH-AMERICAN INVERTEBRATES.

V. FRESH-WATER OSTRACODA.

C. H. TURNER.

THE Ostracoda form a well-defined division of the Entomostraca. They resemble the Lamellibranchiata in having the body enclosed in a bivalve shell. This peculiarity, which causes many a novice to mistake the Ostracoda for small Mollusca, is merely a superficial resemblance; for, although the structure of the enclosed animal is quite primitive, yet it is decidedly crustacean.

The body always bears seven pairs of articulated appendages. The first five of these are head appendages; but, in different groups, either one or all of the last three pairs of these cephalic appendages may be modified for locomotion. The last two pairs belong to the body and are usually known as feet. In some cases (Cypris), however, the last pair of feet is not used for locomotion. In most cases the abdomen terminates in a pair of appendages which resemble legs.

Handicapped by a comparatively heavy shell, the Ostracoda make, as a rule, very poor swimmers. Near the surface in deep waters these creatures are rare. Shallow ponds and marshes are their favorite haunts, but they are also found in rivers and at or near the bottom of lakes. Comparatively speaking, some forms swim quite well (Cypria, Cyclocypris, Cypridopsis), while others do not swim at all, but creep along the bottom or up the stems of plants, or else burrow in the mud or sand (Erpetocypris, Candona).

In the South, specimens may be collected at almost any time of the year, but the spring and fall are the best collecting seasons. In the North they may be collected from early spring to late fall, but spring and fall seem to be the best collecting seasons.

The literature of the Ostracoda is legion, but all known American fresh-water forms are described and figured in the following publications. The first two also contain a fairly complete bibliography up to 1896.

HERRICK, C. L., and TURNER, C. H. Synopsis of the Entomostraca of Minnesota, Copepoda, Cladocera, and Ostracoda. *Geol. and Nat. Hist. Survey of Minn.* 1895.

SHARPE, R. W. Contribution to a Knowledge of the North-American Fresh-Water Ostracoda included in the Families Cytheridæ and Cyprididæ. *Bull. Ill. State. Lab. Nat. Hist.* Vol. iv. 1897.

TURNER, C. H. A Male *Erpetocypris barbatus* Forbes. *Zoöl. Bull.* Vol. ii, pp. 199-202. 1899.

In compiling the following key free use has been made, not only of my own manuscript notes and published papers, but also of the published works of Brady, Vávra, and Sharpe.

The key includes all fresh-water genera known to me, whether they occur in America or not. An attempt is made to incorporate all known American species. A few European forms not yet found in America are included. All such forms are marked with an asterisk (*).

KEY FOR THE DETERMINATION OF THE AMERICAN FRESH-WATER OSTRACODA.

- A. Second antennæ unbranched PODOCOPA
- AA. Second antennæ two-branched.
 - B. One branch rudimentary and immobile . . MYODOCOPA*
 - BB. Both branches developed.
 - C. Basal portion of the first antennæ geniculate, and the branches of the second antennæ flattened
PLATYCOPA*
 - CC. Basal portion of the first antennæ not geniculate, and the branches of the second antennæ not flattened
CLADOCOPA*

TRIBE PODOCOPA.¹

- A. Last pair of legs bent backwards within the shell and not used for locomotion CYPRIDIDÆ (I)

¹ The marine genera *Aglaia*, *Argillœcia*, *Anchistrocheles*, *Cyprois*, *Paracypris*, and *Pontocypris* are not included in this key.

* Contain no fresh-water forms.

- AA.* Last pair of legs directed downwards and used for locomotion.
B. Mandibles slender and styliform . . . *PARADOXOSTOMIDÆ**
BB. Mandibles not styliform and toothed at the extremity.
C. Second maxillæ pediform.
D. Caudal rami obsolete, forming two rounded, setiferous lobes . . . *CYTHERIDÆ* (II)
DD. Caudal rami well developed but small . *BARDIIDÆ**
CC. Second maxillæ not pediform but provided with a pediform palp . . . *DARWINULIDÆ* (III)

I. FAM. CYPRIDIDÆ.

- A.* Second foot terminates with a cylindrical joint that bears two backwardly directed setæ.
B. Second foot of both male and female six-jointed. No branchial plate attached to the second maxillæ . . . *Notodromas* 11
BB. Second foot of the female usually five-jointed and of the male six-jointed. The second maxilla bears a branchial plate.
C. Branchial plate feebly developed in the form of two pectinated setæ.
D. Eye present . . . *Candona* 1
DD. Eye absent . . . *Typhlocypris* 15
CC. Branchial plate developed in the form of three pectinated setæ . . . *Candonopsis* 2
CCC. Branchial plate developed in the form of six pectinated setæ.
D. Palp of second maxilla rudimentary
Ilyocypris 10
DD. Palp of second maxilla normally developed.
E. Terminal joint of the second foot one third as long as the fourth joint or shorter
Cypria 4
EE. Terminal joint of the second foot two thirds as long as the fourth joint . . . *Cyclocypris* 3
AA. Second foot terminates with a beak-shaped joint that bears one backwardly directed claw.
B. Caudal rami rudimentary.
C. Flagellum-like . . . *Cypridopsis* 6
CC. With lamellar base and long seta . . . *Potamocypris* 12
BB. Caudal rami normally developed, cylindrical, terminating in two claws.
C. Natatory setæ of the second antennæ not reaching to the base of the terminal claws . . . *Scottia* 13

- CC. Natatory setæ of the second antennæ reaching to the base, but not to the tips of the terminal claws; claws of abdominal rami smooth or feebly denticulate
Erpetocypris 9
- CCC. Natatory setæ of the second antennæ reaching to or slightly beyond the tips of the terminal claws.
- D. Dorsal setæ of caudal rami rudimentary or absent and the terminal claws of the abdominal rami coarsely denticulate Stenocypris 14
- DD. Dorsal setæ of caudal rami normally developed.
- E. Parthenogenetic Cypris 8
- EE. Sexual Cyprinotus 7
- BBB. Caudal rami exceedingly large and elongated, natatory setæ of both pairs of antennæ well developed, palp and masticatory lobe of first maxillæ narrow Cypricercus 5

1. Candona Baird, 1850.

Antennæ of female five-jointed, of the male six-jointed. Natatory setæ absent. Two characteristic sensory setæ occur between the fourth and fifth joints of the second antennæ of the male. Branchial plate of the second maxilla composed of two unequal pectinated setæ, which are attached to the basal portion of the maxilla. The palp of the second maxilla of the female is two-jointed and terminates with three pectinated bristles; of the male is unjointed and differs in shape from that of the female. Second foot either five- or six-jointed, terminating in two unequally long, backwardly directed setæ and one forwardly directed seta. Caudal rami strong, bearing two terminal claws, the dorsal seta of the ramus usually quite remote from the claws. At the origin of the rami the dorsum of the body terminates in a short seta. Eye small. Males usually more common and larger than the females. Seven rows of chitinous spines arranged around the central cylinder of Zenker's organ. Cannot swim, but creeps along the bottom, or burrows in the mud or sand.

- a. One of the shorter setæ of the tip of the second foot sharply reflexed *C. reflexa* Sharpe
- aa. Setæ at the tip of the second foot not reflexed.
- b. Length of shell about 1.50 mm., shell inequivalve, second foot six-jointed *C. crogmani* Turner
- bb. Length of shell between 0.90 mm. and 1.25 mm.
- c. Caudal rami curved, second foot six-jointed.
- d. Terminal claws of caudal rami stout
C. fabæformis Fischer
- dd. Terminal claws of the caudal rami slender, spines on the first mandibular process of first maxilla not toothed.

- e.* Color white *C. acuminata* Fischer
- ee.* Color greenish yellow variegated with blotches
of brown *C. delawarensis* Turner
- cc.* Caudal rami not curved.
- d.* Terminal claws of rami S-shape . *C. sigmoides* Sharpe
- dd.* Terminal claws not S-shape, the longest one-half as long
as the ramus *C. recticauda* Sharpe

2. *Candonopsis* Vávra, 1891.

Second antennæ similar to those of *Candona*. Mandible bears an extraordinarily long palp. Branchial plate of the second maxilla composed of three plumose bristles. Caudal rami slender, usual dorsal seta absent.

No species of this genus has yet been found in America.

3. *Cyclocypris* Brady and Norman, 1889.

First antennæ seven-jointed. Second antennæ five-jointed in female, six-jointed in male, no olfactory organ on the fourth joint. Natatory setæ of the second antennæ reach far beyond the tips of the terminal claws. Palp of both the mandible and first maxilla normally developed. The second maxilla bears a branchial palp and a plate. This branchial palp in the female is unjointed; in the male it forms a hooked prehensile organ. Last joint of second foot unusually long, being two thirds the length of the fourth joint. Zenker's organ resembles the corresponding organ of *Cypria*. Vas deferens long and convoluted, copulatory organ quadrangular. Males numerous.

- a.* Front edge of caudal ramus about twice as long as its terminal claw
C. lævis O. F. M.
- aa.* Front edge of caudal ramus about two and a half times the length of
the terminal claw.
- b.* Terminal claws of caudal rami strong and much bent
C. forbesi Sharpe
- bb.* Terminal claws of caudal rami slender and not bent
C. modesta (Herrick)
- aaa.* Front edge of caudal ramus about three times the length of the
terminal claws. Terminal claws strong, nearly straight, weakly
bent near the tips *C. globosa** Sars

4. *Cypria* Zenker, 1854.

Second antennæ of the female five-jointed, of the male six-jointed. Distal extremity of the fourth joint of the second antenna bears two olfactory setæ. Natatory setæ of the second antennæ extend far beyond

the tips of the terminal claws. Mandibular palp much elongated. Palp of the first maxilla strongly developed. Second maxilla bears a well-developed branchial plate. In the female the palp of the second maxilla is unjointed and terminates in three setæ; in the male it forms a hooked prehensile organ, and the right and left palp of the male are dissimilar. Caudal rami are robust and the dorsal setæ are situated about midway of the outer border. Eye large. Muscle impressions four. The center of Zenker's organ surrounded by seven whorls of chitinous setæ. The upper part of the organ forms a blind sac, the lower terminates in the funnel-shaped origin of the vas deferens. Copulatory organ triangular. Males numerous.

- a.* Terminal short setæ of the second foot approximately equal.
- b.* Terminal short setæ of the second foot about two times the length of the last joint. Left valve with a dorsal flange; right valve with row of tubercles anteriorly and ventrally
C. pustulosa Sharpe
- bb.* Terminal short setæ of the second foot about as long as the terminal joint.
- c.* Terminal claw of the caudal ramus half the length of the ramus.
- d.* Shell equivalve.
e. Covered with a close reticulum of subparallel lines.
Length 0.54 mm. to 0.64 mm.
C. exculpta (Fischer)
- ee.* Covered with irregularly scattered large puncta.
Length 0.55 mm. to 0.58 mm.
C. ophthalmica (Jurine)
- cc.* Terminal claw of caudal ramus three fifths the length of the ramus or longer.
- d.* Shell inequivalve, valves glossy, finely pubescent.
Length 0.46 mm. to 0.52 mm.
C. inequivalva Turner
- dd.* Shell equivalve, surface smooth, sparsely hairy. Length 0.69 mm. *C. dentifera* Sharpe
- aa.* Terminal short setæ of the second foot evidently unequal.
- b.* Shell covered with numerous almost confluent puncta. Length 0.78 mm. *C. mons* (Chambers)
- bb.* Shell not especially marked in any way. Dorsal seta of ramus three times the width of the ramus from the terminal claws
C. obesa Sharpe

5. Cypricercus Sars, 1895.

"Natatory setæ of both pairs of antennæ well developed; palp and masticatory lobe of the first maxillæ narrow. Caudal rami excessively developed and elongate, affording a ready means of recognition. Cæcal

appendage of the intestine unusually short; ovarian tubes much elongated." [Sharpe.] No American species known.

6. Cypridopsis Brady, 1867.

The first antenna is seven-jointed, the second five-jointed. The five natatory setæ of the second antenna are long and plumose. The branchia of the second maxilla consists either of a plate bearing five plumose setæ or else of two setæ inserted directly on the blade. Second foot five-jointed, bearing at its extremity a strong chitinous claw. Caudal rami rudimentary, flagellum-like. Parthenogenetic.

- a.* Branchia of second maxilla with five setæ. Shell marked with three more or less transverse, dark bands, which are confined to the dorsal and lateral surfaces. Very plump. Common. Length 0.54 mm. to 0.70 mm. *C. cypridopsis* (O. F. Mueller)
- aa.* Branchia of the second maxilla formed of two setæ.
 - b.* Caudal ramus cylindrical and turgid, suddenly narrowing to a bristle *C. newtoni* Brady and Robertson
 - bb.* Caudal ramus broad, gradually narrowing to a bristle.
 - c.* Natatory setæ of the second antennæ reaching to the tip of the terminal claws. Shell pale green
C. villosa (Jurine)
 - cc.* Natatory setæ of the second antennæ reaching beyond the end of the terminal claws. Shell grass green on dorsal aspect *C. smaragdina* Vávra

7. Cyprinotus Brady, 1885.

Shell rather thin, compressed, oval or subtriangular, height exceeding half the length, dorsal margin strongly arched, ventral aspect straight. Valves usually unequal, the left overlapping the right. The free edges of the left valve smooth, cephalic and caudal edges usually bordered with a hyaline flange. The free cephalic edge of the right valve usually armed with tuberculiform teeth. Natatory setæ of the second antennæ reach beyond the tips of the terminal claws. Caudal rami slender with smooth or very finely pectinated claws. Propagation sexual. Copulatory organs small, with an outer linguiform obtuse plate. The cylindrical core of Zenker's organ bears numerous wreaths of spines.

- a.* Length more than three mm.; color bluish white, with a group of scattered, large, sordid, yellowish punctures about the middle of each valve *C. grandis* Chambers
- aa.* Length between one and two mm.
 - b.* Dorsal seta of caudal ramus more than half the length of the sub-terminal claw.

- c.* Dorsal seta the width of the ramus from the subterminal claw. Terminal claw of second foot nearly straight
C. pellucida Sharpe
- cc.* Dorsal seta at least twice the width of the ramus from the subterminal claw. Terminal claw of the second foot strongly curved *C. incongruens* Ramdohr
- bb.* Dorsal seta of caudal ramus not more than half the length of the ramus.
 - c.* Dorsal seta the width of the caudal ramus from the subterminal claw. Shell yellowish brown, marked with bluish black longitudinal stripes on the dorsum and sides, covered with coarse hairs, shell thin *C. burlingtonensis* Turner
 - cc.* Dorsal seta of the caudal ramus twice the width of the ramus from the subterminal claw. Color yellowish green, shell reticulated with contorted lines which are most distinct on the cephalic portion of the valves. Shell thin
crena Turner

8. Cypris O. F. Mueller, 1785.

Second antennæ five-jointed, natatory setæ extending to the tip of the terminal claws. Mandibular palp not extending beyond the tip of the mandibular teeth, the first mandibular process armed with two biarticulate thorns. Branchial plate of the first maxilla large, bearing stiff, plumose setæ. Second maxilla provided with a branchial plate. Caudal rami stout. Parthenogenetic.

- a.* Length three mm. or more.
 - b.* Both spines on the first mandibular process of the first maxilla smooth, dorsal margin of shell strongly convex. Marked with dark bands *C. herricki* Turner
 - bb.* Both spines on the first mandibular process of the first maxilla toothed, dorsal margin of shell nearly straight marked with dark bands *C. perelegans* Herrick
- aa.* Length between one and two mm.
 - b.* Both spines on the first mandibular process of the first maxilla smooth.
 - c.* Terminal claw of the second foot as long as the last joint. Shell noticeably less than three times as long as high.
 - d.* Caudal ramus straight; subterminal claw two thirds as long as the terminal. Shell four ninths as high as long *C. clavata* Baird*
 - dd.* Caudal ramus weakly S-shaped.
 - e.* Subterminal claw of the caudal ramus half as long as the terminal. Shell two thirds as high as long *C. virens* Jurine

- ee.* Subterminal claw of the caudal ramus nearly as long as the terminal. Shell half as high as long
C. altissimus Chambers
- cc.* Terminal claw of the second foot twice as long as the terminal segment. Shell fully three times as long as high. Subterminal claw of the caudal ramus half as long as the terminal *C. fasciata* O. F. Mueller*
- bb.* Both spines on the first mandibular process of the first maxilla toothed.
- c.* Shell not reticulated with broken lines.
- d.* Shell less than twice as long as high, terminal claw of the caudal ramus half as long as the ramus.
- e.* Subterminal claw of caudal ramus three fourths as long as the terminal . . . *C. testudinaria* Sharpe
- ee.* Subterminal claw two thirds as long as the terminal
C. fuscata (Jurine)
- dd.* Shell more than twice as long as high. Terminal claw of the caudal ramus one third as long as the ramus. Subterminal claw two thirds as long as the terminal
C. fischeri Lilljeborg*
- cc.* Shell reticulated. Terminal claw of the caudal ramus nearly three fifths as long as the ramus, terminal seta not more than one fourth as long as the terminal claw
C. reticulata Zaddach
- aaa.* Length between two mm. and three mm., third and fourth joints of the first foot fused *C. pubera* O. F. Mueller*

9. Erpetocypris Brady and Norman, 1889.

General characters of the animal closely approaching those of Cypris; but the natatory setæ of the second antennæ do not reach nearly to the tips of the terminal claws, and they are not plumose. Second maxilla bears a branchial plate. Cannot swim, creeps along the bottom. Most forms parthenogenetic, some sexual.

- a.* Length about four mm. Claw on the last joint of the second foot seven-eighths as long as the last segment. Dorsal seta of the caudal ramus serrate and claw-like, close to the subterminal claw; dorsal edge of ramus finely toothed; ramus twenty times as long as wide; terminal seta about one third as long as the subterminal claw. Shell twice as long as high, the upper margin nearly straight
E. barbata (Forbes)
- aa.* Length between two and three mm.
- b.* Claw on last joint of the second foot as long as that joint, shell about twice as long as high. Caudal ramus about ten times as long as wide, dorsal margin finely toothed *E. strigata* (O. F. Mueller)*

- bb.* Claw of last joint of the second foot three times as long as the last segment. Dorsal edge of caudal ramus armed with five combs of teeth *E. reptans* (Baird)*
- aaa.* Length between one mm. and two mm.
- b.* Dorsal setæ of caudal ramus transformed into a short spine or claw, situated near the subterminal claw. Shell seven thirteenths as high as long . . . *E. olivacea* (Brady and Norman)
- bb.* Caudal ramus with only the terminal claws developed, lacking both the terminal and dorsal setæ. Shell two and a half to three times as long as high . . . *E. minnesotensis* (Herrick)

10. Hyocypris Brady and Norman, 1889.

Shell oblong, with a transverse median depression, coarsely punctate and tuberculate. Second antennal setæ non-plumose, few; reaching a little beyond the apex of the terminal claws. Mandible palp four-jointed, with a setose branchial appendage. First pair of maxillæ composed of four segments, and a large branchial appendage bearing numerous terminal and about five reflexed basal setæ. Second pair of maxillæ consisting of a conical lobe, which bears numerous short marginal setæ, at the apex four stout plumose setæ, and at the base an appendage of four radiating plumose filaments and a biarticulate process bearing three apical setæ, one of which is plumose. The penultimate joint of the second foot has two marginal setæ; the last joint three long apical setæ, but no claw. Caudal rami ending in two long and equal claws and one very short seta, marginal seta long, and attached near the middle of the ramus. No American forms known.

11. Notodromas Lilljeborg, 1853.

Shell of male and female unlike. Second antennæ of both male and female six-jointed, natatory setæ extending beyond the tips of the terminal claws. No branchial plate on the second maxilla; palp of same two-jointed in the female; in the male the terminal segment forms a scythe-shaped appendage. Second foot five-jointed, abdominal ramus long and slender. Eyes two, separate. Males numerous.

- a.* Shell subquadrangular, surface smooth and shining. In the female, the caudo-ventral angle of the shell terminates in a horizontal, backwardly projecting, squamous, spine-like plate
N. monacha (O. F. Mueller)

12. Potamocypris Brady, 1870.

Second antennæ four-jointed; natatory setæ numerous but short, not reaching beyond the middle of the terminal claws; last joint with two

strong terminal claws and two or three short, slender setæ. Mandible stout, palp three-jointed, with a single branchial seta near the base. Feet as in Cypris, caudal rami rudimentary, consisting of a long seta, with a lamellar base bearing a short seta which is usually situated near the base of the lamellar portion. Shell compressed. No American forms known.

13. *Scottia* Brady and Norman, 1889.

Shell not unlike that of the tumid forms of Cypris. Natatory setæ of the second antennæ extremely short, not reaching the base of the terminal claws. Limbs short and stout; claws of the caudal rami very stout, short, and twisted. No American forms known.

14. *Stenocypris* Sars, 1889.

Natatory setæ of the second antennæ not reaching beyond the tips of the terminal claws. Palp of the first maxilla very narrow, cylindrical, the last joint small, the masticatory lobes long and narrow. Caudal rami large, rather lamelliform, dorsal edges occasionally pectinate; claws very unequal, both coarsely denticulate; setæ of dorsal edge absent or small, apical seta long. Parthenogenetic. Shell narrow, height much less than half the length. No American forms known.

15. *Typhlocypris* Vejdovsky, 1882.

Second antennæ five-jointed in the female, six in the male. Natatory setæ of the second antennæ lacking. No eyes. Branchial plate of the second maxilla composed of two unequal plumose seta. No American forms known.

II. CYTHERIDÆ.

Limnocythere Brady, 1868.

Shell strong, irregularly tuberculate or spinous. First antennæ five-jointed, with short bristles on their outer edge. Branchial plate of the mandibles strongly developed. Caudal rami rudimentary, usually only two short bristles. Males rare.

- a. Terminal segment of first antenna seven times as long as wide. Second antennæ not especially armed in male. Rudimentary caudal rami cylindrical, about three times as long as wide

L. reticulata Sharpe

- aa. Terminal segment of the first antenna four to five times as long as wide. Second antenna of the male has its terminal claw armed with three or four strong teeth. Rudimentary caudal rami six to seven times as long as broad *L. illinoisensis* Sharpe

III. DARWINULIDÆ.

Darwinula Brady and Robertson, 1870.

Shell smooth, thin, and fragile. First antennæ short, stout, five- or six-jointed, strongly armed with stout, short setæ. Second antennæ stout, composed of four or five joints, no natatory setæ, no poison gland or urticating setæ. Mandible palp three-jointed, the basal joint large and densely setiferous. First maxilla bears a large branchial plate; the second a small branchial plate and a pediform palp. Post-abdominal rami subconical, small.

- a.* First antennæ composed of six joints, the second antennæ of four. Antepenultimate joint of the second antenna does not bear a conspicuous one-jointed appendage. Length 0.8 mm.

D. stevensoni Brady and Robertson *

- aa.* First antennæ composed of five joints, the second of five. Antepenultimate joint of the second antenna bears a conspicuous one-jointed appendage, which terminates in one long and one short filament. Length 0.68 mm. to 0.70 mm.

D. improvisa Turner